UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/388,826	09/01/99	LI W	MI22-1208

MMC1/0323

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EXAMINER	
KIELIN,E	
ART UNIT	**PAPER NUMBER**
2813	8

DATE MAILED: 03/23/01

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

PTO-90C (Rev. 2/95)
*U.S. GPO: 2000-473-000/44602

1- File Copy

Office Action Summary	Application No. 09/388,826	Applicant(s) Li et al.
	Examiner Erik Kielin	Group Art Unit 2813

☒ Responsive to communication(s) filed on *Mar 2, 2001*.

☒ This action is **FINAL**.

☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire *3* month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) *1, 2, 4-14, 16, 18-25, 34-42, and 44-51* is/are pending in the application.

Of the above, claim(s) *13 and 38* is/are withdrawn from consideration.

☐ Claim(s) ______ is/are allowed.

☒ Claim(s) *1, 2, 4-12, 14, 16, 18-25, 34-37, 39-42, and 44-51* is/are rejected.

☐ Claim(s) ______ is/are objected to.

☐ Claims ______ are subject to restriction or election requirement.

Application Papers

☐ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on ______ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on ______ is ☐ approved ☐ disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) ______.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: ______.

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☒ Notice of References Cited, PTO-892

☐ Information Disclosure Statement(s), PTO-1449, Paper No(s). ______

☐ Interview Summary, PTO-413

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- *SEE OFFICE ACTION ON THE FOLLOWING PAGES* ---

DETAILED ACTION

Election/Restriction

1. This application contains claims directed to the following patentably distinct species of the claimed invention:

Claims 1, 2, 4-12, 14, 16, 18-25, 34-37, 39-42, 44-51 are drawn to the formation of a SiO_2 dielectric, classified in class 438, subclass 787 or subclass 788.

Claims 13 and 38 are drawn to the formation of a SiO_xN_y or SiN_x dielectric, classified in either class 438, subclass 786 or class 438, subclass 791.

Applicant is required under 35 U.S.C. 121 to elect a single disclosed species for prosecution on the merits to which the claims shall be restricted if no generic claim is finally held to be allowable. Currently, claims 1 and 34 are generic.

Applicant is advised that a reply to this requirement must include an identification of the species that is elected consonant with this requirement, and a listing of all claims readable thereon, including any claims subsequently added. An argument that a claim is allowable or that all claims are generic is considered nonresponsive unless accompanied by an election.

Upon the allowance of a generic claim, applicant will be entitled to consideration of claims to additional species which are written in dependent form or otherwise include all the limitations of an allowed generic claim as provided by 37 CFR 1.141. If claims are added after the election, applicant must indicate which are readable upon the elected species. MPEP § 809.02(a).

Should applicant traverse on the ground that the species are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the species to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other invention.

2. During a telephone conversation with Mark Matkin on 3/21/01 a provisional election was made with traverse to prosecute the invention of group I, claims 1, 2, 4-12, 14, 16, 18-25, 34-37, 39-42, 44-51. Affirmation of this election must be made by applicant in replying to this Office action. Claims 13 and 38 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

3. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a petition under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Claim Rejections - 35 USC § 112

4. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to

> make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

5. Claims 16 and 18 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for *a portion* of the $(CH_3)_xSiO_y$ to remain as $(CH_3)_xSiO_y$ upon exposure to the oxygen plasma, does not reasonably provide enablement for all to remain as $(CH_3)_xSiO_y$. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to use the invention commensurate in scope with these claims.

It is held, absent evidence to the contrary that, it is not possible for all to remain as $(CH_3)_xSiO_y$. The prior art to be presented below clearly indicates that the oxygen plasma necessarily reacts with the methyl function, thereby breaking the bonds. See **Wang** et al. (US 6,028,015), **Morita** (JP 63-157443 A), or **Brinker** et al. (US 5,948,482) for verification. Each of which, as indicated below, teaches that oxygen plasma necessarily removes a portion of the organic moiety from the dielectric layer.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 1, 2, 4-7, 10-12, 14, 16, 19-25 are rejected under 35 U.S.C. 103(a) as unpatentable over **Morita** (JP 63-157443 A) in view of **Matsuura** (US 6,124,641).

Morita discloses forming a low-dielectric-constant material comprising phenyl or alkyl silicon oxide 10 which inherently has a dielectric constant of less than 3.5 over an integrated circuit Fig. 2; exposing the dielectric to oxygen plasma to form and upper surface 11 of silicon oxide which is inherently effective to reduce the dielectric constant. (See Figs. 1-2; page 2, lower two column). Note that a whole of the dielectric layer is not converted from one base to another (Applicant's claim 19) and that the $(CH_3)_xSiO_y$ remains as $(CH_3)_xSiO_y$. Note that the plasma exposure time is 10 minutes. Regarding claim 14, **Morita** forms the organic silicon oxide layer using $R_nSi(OH)_{4-n}$ wherein R is any alkyl group. Examiner gives official notice that alkyl inherently includes methyl.

Morita does not teach chemical vapor depositing the dielectric.

Matsuura teaches the benefits over liquid-phase deposition of forming the dielectric layer of **Morita** consisting essentially of $(CH_3)_xSiO_y$ (methyl silicon oxide) over at least partially formed integrated circuits, using plasma-enhanced CVD plus and an oxygen-containing compound (H_2O_2). (See **Matsuura**, Fig. 2; column 2, lines 14-30; columns 4-7).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify any of **Morita** to use PECVD to deposit the methyl silicon oxide, for the benefits indicated in **Matsuura**.

It is held absent evidence to the contrary that the dielectric constant is reduced by at least 10% by exposure to the oxygen plasma and that the dielectric constant is inherently stabilized. If it is thought for some reason that the dielectric constant is not reduced or is not stabilized by exposure to the oxygen plasma, then these may be a difference. But, it has been held, where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not possess the characteristics relied on. See In re Swinhart, 169 USPQ 226,229 (CCPA 1971). See also In re Fitzgerald, 205 USPQ 594 (CCPA 1980) (the burden of proof can be shifted to the applicant to show that subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 USC 102 or obviousness under 35 USC 103). Given the similarity (if not equality) of the dielectric materials formed, the present evidence indicates that the dielectric constant must necessarily be reduced and stabilized.

Regarding claims 5-7, Matsuura does indicate that the oxygen in the oxygen plasma may come from any of O_3, N_2O, and NO_x. Examiner gives official notice that O_3, N_2O, and NO_x are notoriously well known sources of oxygen in plasmas resulting from the plasma-induced decomposition into, among other products, highly reactive oxygen radicals. It would have been obvious to one of ordinary skill in the art at the time the invention was made to use O_3, N_2O, or NO_x as the source of oxygen in the plasma as a matter of design choice of art recognized

equivalents of plasma oxygen sources, or of routine optimization, in order to gain the best oxygen radical source of known oxygen sources for the purpose at hand.

Regarding claim 10, although the upper temperature limit for plasma exposure is not indicated in **Morita**, the choice of temperature is matter of routine optimization with a limited number of species and obvious to one of ordinary skill. See In re Aller, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art general conditions is obvious). It would have been obvious to one of ordinary skill in the art at the time the invention was made to stay below an exposure temperature of 550 C to prevent degradation to the organic portion of methyl silicon oxide which portion is clearly desired to be retained in **Morita** to retain the desired properties associated with the methyl silicon oxide. It would have been obvious to one of ordinary skill in the art at the time the invention was made to optimize the exposure time as per the precedent above to optimize the resulting dielectric properties.

Regarding claim 25, it is held absent evidence to the contrary that the dielectric layer of either **Morita** or **Matsuura** has at least 10 to 50 mol% of methyl groups before and after exposure, based on the molecular formulas indicated therein from which the organic silicon oxide layer is formed or its final form and because only the surface portion is modified by the exposure to oxygen plasma. Furthermore, Applicant has not indicated any criticality to the claimed portions. See In re Hoeschele, 406 F.2d 1403, 160 USPQ 809 (CCPA 1969) (Claimed elastomeric polyurethanes which fell within the broad scope of the references were held to be unpatentable thereover because, among other reasons, there was *no evidence of the criticality* of

the claimed ranges of molecular weight or molar proportions.). Any difference is a matter of routine optimization within prior art general conditions which is obvious as per the precedent indicated above including In re Aller.

8. Claims 1, 2, 4-7, 10-12, 14, 16, 19-25 are rejected under 35 U.S.C. 103(a) as obvious over **Wang** et al. (US 6,028,015) in view of **Matsuura** (US 6,124,641).

Wang discloses forming a low-dielectric-constant material consisting essentially of $(CH_3)_xSiO_y$ (methyl silicon oxide) methyl silicon oxide which inherently has a dielectric constant of less than 3.5 over an integrated circuit (column 3, lines 25-31); exposing the dielectric to oxygen plasma (column 5, lines 3-5) which is inherently effective to reduce the dielectric constant by 10%. (See column 1, line 43 to column 2, line 20; column 3, line 14 to column 4, line 14.) Note that a whole of the dielectric layer is not converted from one base to another; in other words, the $(CH_3)_xSiO_y$ remains as $(CH_3)_xSiO_y$.

Wang does not teach chemical vapor depositing the dielectric.

Matsuura teaches the benefits over liquid-phase deposition of forming the dielectric layer of **Wang** consisting essentially of $(CH_3)_xSiO_y$ (methyl silicon oxide) over at least partially formed integrated circuits, using plasma-enhanced CVD plus and an oxygen-containing compound (H_2O_2). (See **Matsuura**, Fig. 2; column 2, lines 14-30; columns 4-7).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify any of **Wang** to use PECVD to deposit the methyl silicon oxide, for the benefits indicated in **Matsuura**.

The same reasoning regarding inherency used above is applied here.

The same reasoning applied to claims 5-7 and 10 above is applied here.

Regarding claims 20-24, although the exposure time is not indicated in **Wang**, the choice of temperature and exposure time are a matter of routine optimization with a limited number of species and obvious to one of ordinary skill. See In re Aller, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art general conditions is obvious). It would have been obvious to one of ordinary skill in the art at the time the invention was made to optimize the exposure time as per the precedent above to optimize the process in **Wang**.

Regarding claim 25, **Wang** et al. indicates that the carbon portion which is may be methyl groups is present in an amount of "at least 8 wt%" (column 4, lines 58-59) which overlaps Applicant's claimed range of 10 to 50 mol% given that the molecular weights of carbon, oxygen and silicon are about 12, 16, and 28, respectively. Also given that the carbon has a molecular weight of less than half of silicon, at least 8 wt% is at least 16 mol%. (Note that it is assumed that Applicant bases the mole percent on methyl groups to silicon atoms as the oxygen is clearly the variable species and not bonded to the oxygen atoms.) Furthermore, Applicant has not indicated any criticality to the claimed portions. See In re Hoeschele, 406 F.2d 1403, 160 USPQ 809

(CCPA 1969), *supra.* Any difference is a matter of routine optimization within prior art general conditions which is obvious as per the precedent indicated above.

9. Claims 1, 2, 4-7, 10-12, 14, 16, 19-25 are rejected under 35 U.S.C. 103(a) as obvious over **Brinker** et al. (US 5,948,482) in view of **Matsuura** (US 6,124,641).

Brinker discloses forming a low-dielectric-constant material comprising, *inter alia*, methyl silicon oxide which inherently has a dielectric constant of less than 3.5 over an integrated circuit (column 1, lines 17-28; column 4, lines 8-15); exposing the dielectric to oxygen plasma (column 5, lines 11-33) which is inherently effective to reduce the dielectric constant. Note that oxygen plasma exposure is used to "confer additional porosity" which inherently reduces the dielectric constant by at least 10% by incorporating more air or vacuum into the silicon oxide matrix (column 5, lines 25-29). Note that a whole of the dielectric layer is not converted from one base to another and that the $(CH_3)_xSiO_y$ remains as $(CH_3)_xSiO_y$. (See column 5, lines 29-33). (See also column 3, lines 29-30; column 8, Table 1).

Brinker does not teach chemical vapor depositing the dielectric.

Matsuura teaches the benefits over liquid-phase deposition of forming the dielectric layer of **Brinker** consisting essentially of $(CH_3)_xSiO_y$ (methyl silicon oxide) over at least partially formed integrated circuits, using plasma-enhanced CVD plus and an oxygen-containing compound (H_2O_2). (See **Matsuura**, Fig. 2; column 2, lines 14-30; columns 4-7).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify any of **Brinker** to use PECVD to deposit the methyl silicon oxide, for the benefits indicated in **Matsuura**.

The same reasoning regarding inherency used above is applied here.

The same reasoning applied to claims 5-7, 10, 21-24, and 25 above is applied here.

Regarding claim 25, although Brinker does not indicate the beginning and end concentration of methyl groups in the range of 10% to 50%, **Brinker** indicates that only some of the organic groups are removed and that the amount removed is according to the desired properties such as porosity (i.e. dielectric constant) and hydrophobicity desired in the interlayer dielectric. It would have been obvious to one of ordinary skill in the art at the time the invention was made to choose 10 to 50 mol% of carbon as a matter of routine optimization in order to optimize the properties as indicated by **Brinker** and according to established precedent, *supra*.

10. Claims 8, 9, 65, and **34**-37, 39-42, 44-51 are rejected under 35 U.S.C. 103(a) as being unpatentable over any of **Morita, Wang,** and **Brinker**, any in view of **Matsuura** as applied to claims 1, 2, 4-7, 10-12, 14, 16, 19-25 above, and in further view of **Miyasaka** (US 6,017,779).

The prior art as explained above discloses all of the limitations of the claimed invention except for (1) that deposition and exposing in the same chamber is not taught (Applicant's claims 8 and 34); and (2) that shutting off the silicon process gas and maintaining conditions in the chamber to expose the dielectric to the oxygen plasma is not taught (Applicant's claim 35).

Miyasaka teaches a method of forming a silicon oxide layer on a semiconductor device using plasma CVD with silicon-containing compound and a oxygen-containing gas and then shutting off the silicon-containing precursor and then exposing to the oxygen plasma in the same chamber maintained at sub-atmospheric pressure. (See **Miyasaka**, column 44, "Example 6" especially lines 35-52.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify any of **Wang**, **Brinker**, or **Morita**, any in view of **Matsuura** to maintain a device in a single chamber as taught by **Miyasaka** in order to beneficially prevent contamination to the semiconductor device dielectric layer between process steps, as is well known in the art to do.

Response to Arguments

11. Applicant's arguments with respect to all claims have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

12. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication from examiner should be directed to Erik Kielin whose telephone number is (703) 306-5980 and e-mail address is erik.kielin@uspto.gov. The examiner can normally be reached by telephone on Monday through Thursday 9:00 AM until 7:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles Bowers, can be reached at (703) 308-2417 or by e-mail at charles.bowers@uspto.gov. The fax phone number for the group is (703) 308-7722 or -7724.

EK

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March 21, 2001